

The Evolution of Organic Material in the Interstellar Medium

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Dense clouds produce molecules and ices critical to star and planet formation. The formation of organic compounds in these ices is one of the first steps towards the complex molecular materials needed for life. Infrared spectroscopy provides a powerful tool for the study of the composition and evolution of interstellar ices. The most diagnostic features of solid-state materials occur in the mid-infrared. To date, mid-IR absorption studies have primarily been towards embedded protostars where the ice may well have been processed either thermally or by FUV photons from the star. Such sightlines demonstrate a preponderance of simple molecules (H_2O , CH_3OH , CO , CO_2 , and NH_3) and energetically processed species (X-CN) in the surrounding ices, revealing that protostars strongly influence their circumstellar environments. Lines of sight to these objects are unlikely to be representative of dense cloud materials as a whole. A more complete understanding of the composition of dense clouds and their chemical dynamics requires that we also probe lines of sight through the general quiescent cloud medium. Moderate resolution spectra from space (including 6.0 micron H_2O , 6.85 micron $\text{NH}_4^+/\text{CH}_3\text{OH}$, 7.6 micron CH_4 , and 15.2 micron CO_2 band), plus high resolution IRS spectra for selected high AV sources, and corresponding moderate resolution ground-based (3-5.0 micron) observations of dense clouds at a stage prior to star permission are providing new insights into the abundances and densities required for the ice components to appear, allowing the study of chemical changes in molecular clouds as a function of temperature and density. These observations provide a snapshot of the chemical state of a molecular cloud prior to the formation of stars, and a general baseline for studies of dust chemistry in regions of star formation. In addition, our ground-based observations of dense clouds from this early stage through later periods where star formation activity dominates, reveal the evolution, distribution, and composition of the organic component of interstellar dust from its origins in the diffuse interstellar medium to the proto-planetary disk environment.